Carruthers Lasaea Smith

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subject, and his unaffected enthusiasm for his science could not fail to arouse his students' sympathy and interest.

Looking back now, where but a little while ago we thought only of looking forward, it behoves us not to estimate the measure of his work without remembering the difficulties against which he had to contend, and towards all of which he bore himself cheerfully and manfully. And writing these few lines as a tribute to his memory, my thoughts dwell not more upon his scientific work than on his personal character, for it was beyond common measure pure and lovable.

D. W. T.

A DISEASE IN TURNIPS CAUSED BY BACTERIA.

By W. Carruthers, F.R.S., and A. Lorrain Smith.

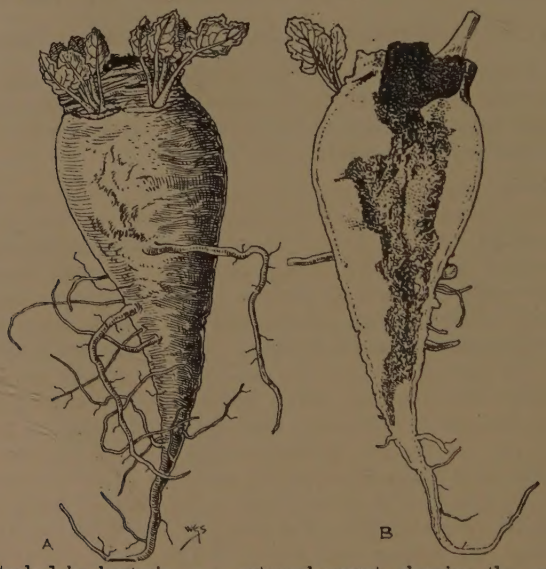
[This memoir was prepared for the Royal Agricultural Society. By permission of the Society it appears here contemporaneously with its publication in the Society's Journal, but with a few technical additions for scientific readers.—Ed.]

For some years we have been acquainted with an injury to turnips, the cause of which we were unable to discover. The injured turnips had the crown of young leaves destroyed, and a cavity scooped out of the turnip occupied the top immediately below where the leaves had grown. The cavity was empty; its wall was of a dark brown colour, and the tissues were protected by the development of a corky layer. There was no indication of injury in the turnip beyond the wall of the empty cavity. The first specimen was received seven years ago, and some years later other specimens were obtained; they threw no light on the cause of the injury. It seemed probable that the injury was due to bacteria, but we did not discover any evidence of their presence.

At the beginning of August, 1900, a number of badly diseased swede turnips were sent from the valley of the Nibb, in Yorkshire, in order that the nature and cause of the injury might be determined. In the worst cases the young leaves had disappeared from the crown or were rotting away; the outer older leaves also showed signs of wilting, their stalks were decaying at the base, and a number of lateral buds were shooting up from the axils of these older leaves. As a rule, the outer skin of the turnip was intact, In some instances the top was as if scooped out, and the depression lined by a whitish slimy substance. In others the injury had further penetrated through the turnip to the base, and the whole centre was a mass of rotten pulp. Even in the plants less seriously affected, it was evident from the condition of the younger leaves that they were being cut off from their connection with the root. Some of the turnips had wounds at the side, through which the bacteria gained access, forming starting-points of disease in addition to the injury at the top of the bulb. In the specimen figured an older cavity was found agreeing with the injury already observed.

From the base of this cavity a later attack was developed. This, with other characters, clearly established that it was the mysterious disease we were dealing with. Some of the turnips were suffering from Finger and Toe, which was of course quite distinct from the rottenness that was destroying the turnips.

A careful microscopic examination of leaf and bulb was made, and it was found that the injury was due to bacteria, which had gained access to the living plants between the bases of the young leaves or through the broken surface of the bulb. They were advancing into the substance of the turnip from cell to cell, destroying the tissues as they went. Sections were taken from the diseased parts and examined, and myriads of the bacteria were seen in the cells. They were motile, cylindrical rods, exceedingly minute, the



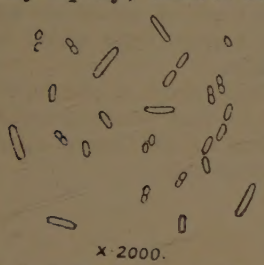
Turnip attacked by bacteria. — A, external aspect, showing the crown killed and new growth from the axils of the first leaves, which had naturally fallen off; B, section of the same turnip, showing the crown of the turnip destroyed, the hollow cavity produced by the first stage of the disease, and the further injury by the bacteria in the centre of the turnip. Both half natural size.

longest about seven times as long as they were broad; they measure ·65 μ in breadth, and from 1· to 4· μ in length. The larger rods multiplied by division into two and four, and thus they varied greatly in length, though not in width.

Some of the slimy substance from the cavity at the top of the turnip was stained and examined, and was found to be crowded with the same bacteria. Cultures were tried in a mixture of gelatine and turnip decoction by introducing into the mixture the bacteria taken from different parts of the diseased swedes, the medium and instruments being carefully sterilized; and little colonies of very active

rods were formed in a day or two, which liquified the gelatine, Unfortunately, there was no opportunity at the time of infecting healthy swedes from these colonies, and of following the entire life history of the bacteria.

As a careful field examination seemed desirable, a visit was made to the injured crops in Yorkshire. The disease had advanced very rapidly; fields of swedes that appeared healthy and thriving a fortnight previously were now completely blighted. In the worst field, twenty-five acres in extent, not one turnip in five seemed to have escaped. Yellow turnips had suffered very little, though here and here a few plants growing on the head rows of the fields containing diseased swedes were attacked; cabbages growing near were also diseased, but a strip of kohl-rabi right through the centre of a severely diseased crop was quite healthy.



Bacteria which cause the disease in the turnip. Magnified 2000 diameters.

The kohl-rabi appears so far to be immune, and cabbages and yellow turnips are probably safe when not in contact with a diseased crop. The mangolds growing in the same field were not in the least attacked. In all cases the bacteria had lodged in the central bud, by destroying the tissues of the turnip below, so that the young leaves were cut off from their connection with the root, and they speedily withered and died. Where circumstances favoured the development of the bacteria, they increased rapidly, and the whole interior of the root from the crown downwards was soon destroyed.

For the information of farmers, who in some districts were alarmed at the serious injury to their crops, a letter was published four months ago in the *Times* and other daily papers, and in the *Agricultural Gazette*, giving a general account of the nature of the disease, and suggesting steps to be taken to prevent its spreading.

The disease worked great havoc in Yorkshire, and the same injury was reported from two localities at a distance from each other in Dumfriesshire. At a later period the progress of the disease was to a large extent arrested. This no doubt arose from the destruction of so many leaves, which left the rows somewhat bare. Sunlight and air gained free access to the bulbs, and the bacteria were dried up or destroyed.

Many investigators in recent years have experimented on the influence of sunlight on bacteria, and have proved that in most cases they develop only in darkness. In 1877 and 1878 Downes and Blunt found that, while their growth was retarded by the influence of diffused white daylight, it was completely stopped by sunshine. Another observer found that the destruction of germs was more rapid and complete when there was also a free admittance of air, though one of the most recent workers in this field, Professor Marshall Ward, has shown that the sun's rays alone are sufficient to kill them. He confirmed this view by exposing to the light plate cultures of the spores of the anthrax bacteria covered with

pieces of cardboard, out of which figures and letters had been cut, thus allowing the direct influence of the sun to act on the well-defined areas cut out of the card. The spores were inactive on the exposed patches, the gelatine remaining clear, while the darkened parts underneath the cardboard were opaque with the crowded colonies of bacteria that had developed from the spores.

The same influence appears to have been equally powerful in the turnip-field, for in many cases the only trace of injury left was a clean walled cavity at the top of the turnip, from which no information could be gathered as to its origin.

It is very doubtful whether any true reparation of the injury followed the growth in the lateral buds. These young growths could not arrest the progress of the bacteria in the turnip, much less could they repair the injury that had been done.*

SHORT NOTES.

Aublet's 'Histoire des Plantes.'—Dr. Otto Kuntze, during his recent visit to this country, called my attention to a peculiarity in the Kew copy of Aublet's *Histoire des Plantes de la Guiane française:* namely, at p. 440 there is a genus *Tamonea* established, completed on the following page with the specific name *guianensis*. This had been duly registered in the *Index Kewensis*, but he had not been able to verify the citation in any copy on the continent. On further examination it was seen that the *Tamonea* on p. 440 was not indexed by Aublet, but *Fothergilla admirabilis* was given instead. I have since then referred to such copies of the book as I could find in London, with this result, that the Banksian copy at the Natural History Museum is like the Kew copy, while the copy in the Linnean Society's Library, and two copies in the British Museum at Bloomsbury, are like those described by Dr. Kuntze—that is, at the place mentioned the name is changed to *Fothergilla admirabilis*, and on the plate (t. 175) to *mirabilis*. I can only suggest that the author found out when indexing that he had printed two genera *Tamonea* (pp. 440, 659), and consequently cancelled the two leaves, pp. 339–442; the issue of the uncorrected copies must have been accidental. It would be interesting to know if any other copies are like those at Kew, and the Botanical Department, British Museum.—B. Daydon Jackson.

New British Hepaticæ.—During a fortnight's visit in June, 1900, to the Ben Lawers district of Perthshire, I added the following hepatics to our flora:—*Cephalozia pleniceps* (Aust.) c. per., growing

* Some days after this paper was in type for the Royal Agricultural Society's Journal, Prof. Potter read to the Royal Society a paper giving the results of investigations he had been making on this turnip disease. By his kindness we received a proof of his paper the day before it was read. He named the bacterium *Pseudomonas destructans*.